SELECTED LITERATURE OF PVA FOAM USED IN WOUND TREATMENT (2000-2009)

The recent introduction of a technology that uses topical negative pressure (TNP) via a polyurethane (PU) or polyvinyl alcohol (PVA) foam dressing to enhance wound healing is particularly welcome, and its use has seen a paradigm shift in the management of many different wound types.

PVA foam has been used as a temporary skin substitute since 1977. PVA is a white, monolayered, microporous sponge. In animal experiments it was shown that cell detritus, fibrin-fur and micro-organisms were taken in and kept inside the material. This effectively cleans the wound surface, the so-called "micro-debridement" process. The effect is due to a strong adherence and a high capacity to absorb fluids, just at the time that the wound is infected.

Scanning Electron Microscopic pictures show coagulated secretions and cell detritus being caught within pores of the PVA sponge that will removed at change of the foam dressing.

Literature: Mutschler W, Burri C, Meyer H, Mohr W, Plank E. Tierexperimentelle Untersuchungen zur Wirksamkeit verschiedener temporärer Hautersatzmaterialen bei Verbrennungen und infiziertyen Wunden. Akt. Traumatol. 8, 375 (1978).

WIKIPEDIA: Negative pressure wound therapy (NPWT), also known as **topical negative pressure** or **sub-atmospheric pressure** dressings, is a therapeutic technique used to promote healing in acute or chronic wounds and enhance healing of first and second degree burns. The therapy involves the controlled application of sub-atmospheric pressure to the local wound environment, using a sealed wound dressing connected to a vacuum pump. The use of this technique in wound management increased dramatically over the 1990s and 2000s and a large number of studies have been published examining NPWT.

Research on the effectiveness of NPWT is generally flawed and methodologically poor quality, but does support the use of the technique for diabetic ulcers and is mixed, but suggestive for other types of wounds.

A 2007 Cochrane Review stated that the evidence comparing NPWT to alternative care was flawed and required more study, but the evidence did support improved healing and called for more, better quality research to be conducted.

A 2010 systematic review found "consistent evidence of the benefit of NPWT" in the treatment of diabetic ulcers of the feet. Results for bedsores was "conflicting" and research on "mixed wounds" was of poor quality, but promising. The review did not find evidence of increased significant complications. The review concluded "There is now sufficient evidence to show that NPWT is safe, and will accelerate healing, to justify its use in the treatment of diabetes-associated chronic leg wounds. There is also evidence, though of poor quality, to suggest that healing of other wounds may also be accelerated."

Selected references on NPWT with regard to use of PVA foam (2000-2009)

Problem-adapted application of vacuum occlusion dressings: case report and clinical experience

Eur J Plast Surg (2000) 23:386–390

Clinical experience has convinced us of the effectiveness of also applying a vacuum dressing combined with split skin transplantation in phase 2. The collapsed foam draws the skin graft into the wound bed, adapting to the contours of all surface irregularities. The same positive effects of occlusive vacuum application on an open wound (oxygenation, bacterial control, tissue growth, vascularization) may also be assumed for grafts. They seem to take faster and more completely, even in the type of wound beds which normally would have required conventional dressings for a longer time before skin grafting, e.g., ischemic fibrotic beds, denuded tendons, or fatty tissue. Scientific proof, however, is still required [3,4]. The potential advantages of applying PU foam in phase 1 and PVA foam in phase 2, as described in the two-phase therapy, needs to be validated experimentally. The beneficial effect of this strategy has only been observed clinically.

Functional T lymphocytes infiltrate implanted polyvinyl alcohol foams during surgical wound closure therapy

Clin Exp Immunol 2001; 124:398±405

Vacuum-assisted closure involving the implantation of polyvinyl alcohol foam is a technique recently developed for the treatment of patients suffering from either wound infection or chronic wounds. This method has been shown to improve and accelerate wound healing. However, little is known about the cell populations that infiltrate the foam, and their potential role in resolving the infection and promoting granulation tissue formation. Our study demonstrates that wound-implanted foams are mainly infiltrated with granulocytes, but that mononuclear cells, including macrophages and minor populations of T, B and natural killer lymphocytes, are also present. We show that foam-infiltrating T cells, especially CD41 T cells, constitute a phenotypically and functionally heterogeneous population influenced by wound infecting bacteria. Thus, T lymphocytes could play a role in wound cleansing. In addition, our data indicate that implanted polyvinyl alcohol foams might be suitable microenvironments for manipulating T cell-mediated immune responses in patients.

Vacuum-sealing fixation of mesh grafts

Eur J Plast Surg (2003) 26:186–190

The meshed skin graft is placed on the wound surface and after being adapted to the margins is sutured into place. This prevents dislocation of the graft caused by constriction of the pad upon release of the vacuum. A polyvinyl alcohol (PVA) pad supplied with 16-Charrière drainages is placed on the wound surface such that it slightly overreaches the wound margins and is in direct contact with the skin and the skin graft.

Use of the white PVA pad prevents adhesion of the graft to the dressing.

The Use of Vacuum-Assisted Closure in the Treatment of Posttransplant Wound Infections: A Case Series

J Heart Lung Transplant 2005; 24:1444

VAC dressings were then applied in all patients according to our unit's previously published protocol.(6) For wounds with low-to-moderate exudate, the black polyurethane foam dressing was used

with continuous negative suction of 125 to 150 mm Hg generated by the portable pump. For wounds with copious exudates, the open-pored white polyvinylalcohol (PVA) foam was used with up to 175 mm Hg suction.

DRESSINGS IN THE MANAGEMENT OF ACUTE ENTEROCUTANEOUS FISTULAS

ANZ J. Surg. 2006; 76: 1085–1087

Recently KCI have developed guidelines for the use of the VAC system for enterocutaneous fistulas. (10,17) These include methods to minimize the risk of small bowel injury. They recommend protecting the mouth of the fistula from the polyurethane foam by covering it with a single layer of a meshed non-adherent dressing and with Softfoam. Softfoam is a premoistened non-adherent PVA foam, which is denser than (pore size 200 lm) polyurethane foam and prevents the in-growth of granulation tissue. With the fistula protected, the goal of the vacuum pressure is to collapse the edges of the fistula together (in the same way that the edges of the wound are pulled inwards) so that the fistula self seals.

Vacuum therapy in dermatology: a review / Die Vakuumtherapie in der Dermatologie: ein Überblick

JDDG | 6˙2006 (Band 4)

Two sponges are available [6, 7]. A black polyurethane (PU) sponge with a pore size of 400–600 Um intended for deep defects as granulation is strongly promoted and the pore size is suitable for heavy secretions. With a longer duration of application (over 4 days) it can grow together with the wound's base. This can be prevented by placing gauze under the sponge also facilitating dressing change. For more superficial ulcerations there is a white polyvinyl alcohol (PVA) sponge with a pore size of 90–120 µm, which promotes granulation to a lesser degree and is suitable for wounds with less secretion. This sponge can remain on the wound for up to 5 days. Both materials have proved themselves in the field of tissue engineering [7].

7. Vogt PM, Kall S, Boorboor P, Lahoda L-U.
Aktuelle- und Zukunftsaspekte zur Interaktion von Schwamm und Wunde in der Vakuumtherapie. Zentralbl Chir 2004; 129: 92–94.

Use of Vacuum Assisted Closure in Vascular Graft Infection Confined to the Groin

Acta chir belg, 2007;107:37-44

Recently VAC therapy has been reported as an adjunctive measure after groin infections involving exposed bypass grafts or as a definite treatment approach to deal with such lesions. GIOVANNINI *et al.* used VAC therapy for treating a patient in poor general condition, presenting with purulent groin wound dehiscence and vascular patch exposure following a common femoral artery revascularization procedure (26). After 19 days of treatment, the vascular prostheses was covered with granulation tissue, wound size had decreased substantially and the patient's condition improved. PICONY *et al.* treated 24 patients with periprosthetic infection (grade III according Szilagyi) by the insertion of a PVA vacuum sponge system (8). They used a modified treatment protocol lasting 14 days with sponge exchange after 7 days and closure of the wound by vertical mattress suture and continuous suction by means of a vacuum fluid removal system connected to the Redon drain, with the achieved vacuum fluctuating between 400 and 600 mmHg. All wounds were definitely closed after 14 days and the authors concluded that deep wound infections in the vicinity of underlying prosthetic material in the groin can be successfully and cost-effectively treated by application of a PVA-vacuum sponge system.

8. PICONY J., ALBES J. M.,WICKE C. *et al.* Treatment of periprosthetic soft tissue infection of the groin following vascular surgical procedures by means of a polyvinyl alcohol-vacuum sponge system. *Wound Repair Regen*, 2003, 11 : 104-9.

26. GIOVANNINI U. M., DEMARIA R. G., CHAPTAL P. A. *et al.* Negative pressure for the management of an exposed vascular dacron polyester patch. *Ann Plast Surg*, 2001, 47 : 577-8.

A feasibility study on chronic wounds of laser Doppler perfusion imaging during Topical Negative Pressure therapy

IFMBE Proceedings, 2008;22:948–951

The chronic wound was prepared for TNP therapy with a white polyvinyl alcohol (PVA) hydro foam (Coldex, Mondomed NV), which was fitted to the patient's wound. An evacuation tube

connected to a wound drainage pump Exsudex; the Medical Company, Amersfoort, the Netherlands) was placed underneath the foam and an adhesive semipermeable drape (Tegaderm, 3M) was placed over the foam to create a seal.

Vacuum-assisted closure – what is evidence based?

Eur Surg (2008) 40/1: 11–18

VT is used with PU and PVA foams in-vivo. Foam related materials are still used in tissue engineering. Tissue engineering (TE) is a relatively new, interdisciplinary and multidisciplinary field that has seen intense development in recent years. One of the main motivations for TE research is the chronic shortage of organ donors and other limitations related to organ and tissue transplantation. The idea that tissues, and ultimately organs, can be ‘‘engineered’’ to be used in patients requiring transplantation is revolutionary and stimulating. However, TE is a discipline still in its infancy, an intricate puzzle far from being completed. One key piece of this puzzle is the scaffold that provides temporary support for cell proliferation and differentiated function, allowing neotissue formation and initial remodelling. VT using matrix materials to increase cell proliferation, angiogenesis and depth of penetration could be the key aims of future studies.

V.A.C.® Therapy in the management of paediatric wounds: clinical review and experience

Int Wound J 2009; 6:1–26

There are many therapies available to physicians for treating paediatric wounds. One such therapy is Vacuum Assisted Closure® (V.A.C.® Therapy, KCI Licensing Inc., San Antonio, TX), an integrated wound therapy system that applies controlled, negative pressure to acute and chronic wounds via an open cell, reticulated polyurethane foam or polyvinyl alcohol (PVA) foam dressing. The system prepares the wound bed for closure by removing excessive interstitial fluid and infectious materials, decreasing oedema and promoting perfusion and granulation tissue formation (5).

The methods and clinical effectiveness of negative pressure wound therapy with reticulated open cell foam (NPWT/ROCF) are well documented in adult wounds through published randomised

controlled clinical trials. Although NPWT/ROCF has not yet been formally evaluated in paediatric wounds in controlled clinical trials, there is a small but growing number of peer-reviewed case series reflecting its safety and efficacy (4,6–17).

More recently, Contractor *et al*. have provided an overview summarising the results of a comprehensive review of the literature on the use of NPWT/ROCF exclusively in paediatric patients (18). To date, adjunctive use of the therapy has been reported in 27 paediatric focused studies to treat a wide variety of wounds and conditions including abdominal compartment syndrome (ACS), pilonidal disease, sternal and other dehiscences, giant omphalocele, gastroschisis, burns and extremity wounds in paediatric patients of all ages. Therapy advantages reported in the paediatric NPWT/ROCF literature mirror those reported in adult studies, which include facilitating wound closure (4,9,13,19), decreasing the need for muscle flaps (12), improving wound bed preparation and graft take (14,15), helping in controlling inflammatory response (20), and reducing costs (6).

Analysis of Effective Interconnectivity of DegraPol-foams Designed for Negative Pressure Wound Therapy

Materials 2009, 2, 292-306

Polyvinyl alcohol (PVA) is prepared by partial or complete hydrolysis of polyvinyl acetate to remove acetate groups and then polymerized. Polyvinyl alcohol has excellent film forming, emulsifying, and adhesive properties [28-30]. It has high tensile strength as well as flexibility. However these properties are dependent on humidity, such that under higher humidity conditions more water is absorbed. Water acts as a plasticiser reducing PVA's tensile strength and making it softer, but increases its elongation and tear strength [31]. Therefore it has been clinically used to prevent postoperative adhesions [32,33] or as cartilage replacement [31,34].

The diameter of PVA-foams increased by ~ 41 ± 12 % showing increased softness as to be expected when PVA-foams are swollen in watery solution. In contrast DP- and PU-foams showed considerable less swelling (< 2 ± 3 %). Equilibrium swelling was reached for all types of foams after 4 h.

Consistent with our findings would be that PU-foams induce very strong granulation tissue formation *in vivo* that often results in tight

tissue ingrowth into the PU-foams during NPWT (personal communication D.M.). This is found less when PVA-foams were used. Other groups have explored PVA's chemical characteristics when using PVA-films or foams in applications where tissue ingrowth is not desired such as to prevent postoperative adhesions [32,33].